



PRELIMINARY

NLT Technologies, Ltd.

TFT COLOR LCD MODULE

NL10276AC30-42C

38cm (15.0 Type)

XGA

LVDS interface (1port)

PRELIMINARY DATA SHEET

DOD-PP-1450 (4th edition)

**This PRELIMINARY DATA SHEET is updated
document from DOD-PP-1436(3)**

**All information is subject to change without notice.
Please confirm the sales representative before
starting to design your system.**

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INTRODUCTION

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The products are classified into three grades: "**Standard**", "**Special**", and "**Specific**".

Each quality grade is designed for applications described below. Any customer who intends to use a product for application other than that of Standard is required to contact an NLT sales representative in advance.

The Standard: Applications as any failure, malfunction or error of the products are free from any damage to death, human bodily injury or other property (Products Safety Issue) and not related the safety of the public (Social Issues), like general electric devices.

Examples: Office equipment, audio and visual equipment, communication equipment, test and measurement equipment, personal electronic equipment, home electronic appliances, car navigation system (with no vehicle control functions), seat entertainment monitor for vehicles and airplanes, fish finder (except marine radar integrated type), PDA, etc.

The Special: Applications as any failure, malfunction or error of the products might directly cause any damage to death, human bodily injury or other property (Products Safety Issue) and the safety of the public (Social Issues) and required high level reliability by conventional wisdom.

Examples: Vehicle/train/ship control system, traffic signals system, traffic information control system, air traffic control system, surgery/operation equipment monitor, disaster/crime prevention system, etc.

The Specific: Applications as any failure, malfunction or error of the products might severe cause any damage to death, human bodily injury or other property (Products Safety Issue) and the safety of the public (Social Issues) and developed, designed and manufactured in accordance with the standards or quality assurance program designated by the customer who requires extremely high level reliability and quality.

Examples: Aerospace system (except seat entertainment monitor), nuclear control system, life support system, etc.

The quality grade of this product is the "**Standard**" unless otherwise specified in this document.



PRELIMINARY

NLT Technologies, Ltd.**NL10276AC30-42C**

CONTENTS

INTRODUCTION	2
1. OUTLINE	4
1.1 STRUCTURE AND PRINCIPLE	4
1.2 APPLICATION	4
1.3 FEATURES	4
2. GENERAL SPECIFICATIONS.....	5
3. BLOCK DIAGRAM.....	6
4. DETAILED SPECIFICATIONS.....	7
4.1 MECHANICAL SPECIFICATIONS	7
4.2 ABSOLUTE MAXIMUM RATINGS.....	7
4.3 ELECTRICAL CHARACTERISTICS.....	8
4.3.1 LCD panel signal processing board	8
4.3.2 Backlight.....	9
4.3.3 Power supply voltage ripple.....	9
4.3.4 Fuse.....	9
4.4 POWER SUPPLY VOLTAGE SEQUENCE	10
4.4.1 LCD panel.....	10
4.4.2 LED driver board	10
4.5 CONNECTIONS AND FUNCTIONS FOR INTERFACE PINS	11
4.5.1 LCD panel signal processing board	11
4.5.2 Backlight lamp.....	12
4.5.3 Positions of plug and socket	12
4.5.4 Connection between receiver and transmitter for LVDS	13
4.5.5 Input data mapping	16
4.6 DISPLAY COLORS AND INPUT DATA SIGNALS.....	17
4.6.1 Combinations of input data signals, FRC and MSL signal	17
4.6.2 16,777,216 colors.....	18
4.6.3 262,144 colors.....	19
4.7 DISPLAY POSITIONS	20
4.8 INPUT SIGNAL TIMINGS	21
4.8.1 Outline of input signal timings	21
4.8.2 Timing characteristics.....	22
4.8.3 Input signal timing chart	23
4.9 OPTICS.....	24
4.9.1 Optical characteristics.....	24
4.9.2 Definition of contrast ratio.....	25
4.9.3 Definition of luminance uniformity	25
4.9.4 Definition of response times	25
4.9.5 Definition of viewing angles.....	25
5. ESTIMATED LUMINANCE LIFETIME.....	26
6. RELIABILITY TESTS	27
7. PRECAUTIONS	28
7.1 MEANING OF CAUTION SIGNS	28
7.2 CAUTIONS	28
7.3 ATTENTIONS.....	28
7.3.1 Handling of the product	28
7.3.2 Environment.....	29
7.3.3 Characteristics.....	29
7.3.4 Others.....	29
8. OUTLINE DRAWINGS.....	30
8.1 FRONT VIEW	30
8.2 REAR VIEW	31
REVISION HISTORY	32

PRELIMINARY

NLT Technologies, Ltd.**NL10276AC30-42C**

1. OUTLINE

1.1 STRUCTURE AND PRINCIPLE

Color LCD module NL10276AC30-42C is composed of the amorphous silicon thin film transistor liquid crystal display (a-Si TFT LCD) panel structure with driver LSIs for driving the TFT (Thin Film Transistor) array and a backlight.

The a-Si TFT LCD panel structure is injected liquid crystal material into a narrow gap between the TFT array glass substrate and a color-filter glass substrate.

Color (Red, Green, Blue) data signals from a host system (e.g. signal generator, etc.) are modulated into best form for active matrix system by a signal processing circuit, and sent to the driver LSIs which drive the individual TFT arrays.

The TFT array as an electro-optical switch regulates the amount of transmitted light from the backlight assembly, when it is controlled by data signals. Color images are created by regulating the amount of transmitted light through the TFT array of red, green and blue dots.

1.2 APPLICATION

- For industrial use

1.3 FEATURES

- Adoption of ST-NLT (Super-Transmissive Natural Light TFT)
- High luminance
- High Contrast
- Low reflection
- LED backlight type
- LED driver Built-in
- LVDS interface
- Replaceable lamp holder for backlight



PRELIMINARY

NLT Technologies, Ltd.

NL10276AC30-42C

2. GENERAL SPECIFICATIONS

Display area	304.128 (H) × 228.096 (V) mm
Diagonal size of display	38.0cm (15.0 inches)
Drive system	a-Si TFT active matrix
Display color	16,777,216 colors (At 6 bit + FRC)
Pixel	1024 (H) × 768 (V) pixels
Pixel arrangement	RGB (Red dot, Green dot, Blue dot) vertical stripe
Dot pitch	0.099 (H) × 0.297 (V) mm
Pixel pitch	0.297 (H) × 0.297 (V) mm
Module size	326.5 mm (W) (typ.) × 253.5 mm (H) (typ.) × TBD (D) mm (typ.)
Weight	TBD
Contrast ratio	600:1 (typ.)
Viewing angle	At the contrast ratio ≥10:1 • Horizontal: Right side 80° (typ.), Left side 80° (typ.) • Vertical: Up side 80° (typ.), Down side 80° (typ.)
Polarizer surface	Clear + Antireflection (AR)
Polarizer pencil-hardness	2H (min.) [by JIS K5600]
Color gamut	At LCD panel center 60% (typ.) [against NTSC color space]
Response time	Ton+Toff (10%←→90%) 8ms (typ.)
Luminance	At the maximum luminance control 600 cd/m ² (typ.)
Signal system	LVDS 1port
Power supply voltage	LCD panel: 3.3V LED backlight: 12V
Backlight	LED backlight type (Replaceable part • Lamp holder set: Type No. TBD)
Power consumption	At the maximum luminance control, Gray pattern ≤ 12.2 W (typ.)

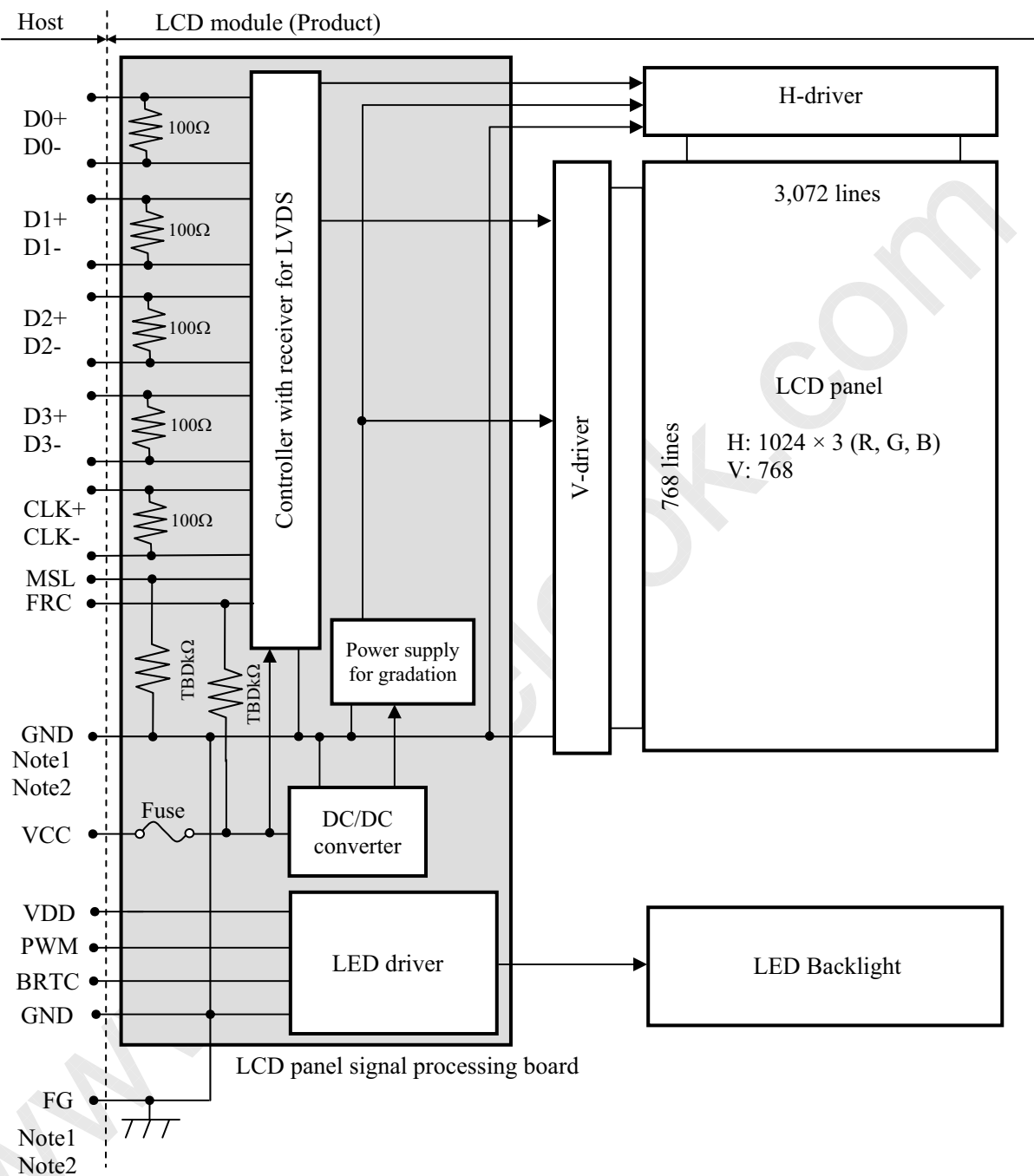
4

PRELIMINARY

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NL10276AC30-42C

3. BLOCK DIAGRAM



Note1: Relations between GND (Signal ground and LED driver ground) and FG (Frame ground) in the LCD module are as follows.

GND- FG	Connected
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Note2: GND and FG must be connected to customer equipment's ground, and it is recommended that these grounds be connected together in customer equipment.



PRELIMINARY

NLT Technologies, Ltd.

NL10276AC30-42C

4. DETAILED SPECIFICATIONS

4.1 MECHANICAL SPECIFICATIONS

Parameter	Specification	Unit
Module size	326.5 ± 0.5 (W) × 253.5 ± 0.5 (H) × TBD (D) Note1	mm
Display area	304.128 (H) × 228.096 (V) Note1	mm
Weight	1,000 (typ.), TBD (max.)	g

Note1: See "8. OUTLINE DRAWINGS".

4.2 ABSOLUTE MAXIMUM RATINGS

Parameter		Symbol	Rating	Unit	Remarks
Power supply voltage	LCD panel	VCC	-0.3 to +4.0	V	Ta= 25°C
	LED driver	VDD	-0.3 to +33.0		
Input voltage for signals	Display signals Note1	VD	-0.3 to +1.98	V	
	Function signals Note2	VF	-0.3 to VCC		
	Function signal for LED driver	PWM	-0.3 to +5.5	V	
			BRTC	-0.3 to +5.5	
Incident light intensity		II	150,000	lx	Note3
Storage temperature		Tst	-30 to +80	°C	-
Operating temperature	Front surface	TopF	-20 to +70	°C	Note4
	Rear surface	TopR	-20 to +70	°C	Note5
Relative humidity Note6		RH	≤ 90	%	Ta ≤ +40°C
Absolute humidity Note6		AH	≤ 70	g/m ³	Ta > +50°C

Note1: D0+/-, D1+/-, D2+/-, D3+/- and CLK+/-

Note2: MSL

Note3: If the product surface (polarizer) is exposed to an ultraviolet ray, the polarizer may discolor (Surface treatment may be damaged.). Use a filter to protect the polarizer from the ultraviolet ray.

Note4: Measured at LCD panel surface (including self-heat)

Note5: Measured at LCD module's rear shield surface (including self-heat)

Note6: No condensation.



PRELIMINARY

NLT Technologies, Ltd.

NL10276AC30-42C

4.3 ELECTRICAL CHARACTERISTICS

4.3.1 LCD panel signal processing board

(Ta= 25°C)

Parameter		Symbol	min.	typ.	max.	Unit	Remarks
Power supply voltage		VCC	3.0	3.3	3.6	V	-
Power supply current		ICC	-	400 Note1	(780) Note2	mA	at VCC= 3.3V
Permissible ripple voltage		VRPC	-	-	300	mVp-p	for VCC
Differential input threshold voltage	High	VTH	-	-	+100	mV	at VCM= 1.25V Note3
	Low	VTL	-100	-	-	mV	
Terminating resistance		RT	-	100	-	Ω	-
Input voltage for MSL signals	High	VFH	1.65	-	VCC	V	-
	Low	VFL	0	-	0.40	V	
Input current for MSL signal	High	IFH	-	-	(50)	μA	-
	Low	IFL	-10	-	-	μA	

Note1: Checkered flag pattern [by EIAJ ED-2522]

Note2: Pattern for maximum current

Note3: Common mode voltage for LVDS receiver

PRELIMINARY

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NL10276AC30-42C

4.3.2 Backlight

(Ta= 25°C)

Parameter		Symbol	min.	typ.	max.	Unit	Remarks
Power supply voltage		VDD	10.8	12.0	12.6	V	Note1
Power supply current		IDD	-	900	≤ (1200) Note2	mA	At the maximum luminance control. Note2
Permissible ripple voltage		VRPD	-	-	200	mVp-p	for VDD
Input voltage for PWM signal	High	VDFH1	1.2	-	-	V	-
	Low	VDFL1	-	-	0.4	V	
Input voltage for BRTC signal	High	VDFH2	1.5	-	-	V	-
	Low	VDFL2	0	-	0.8	V	
PWM frequency		f _{PWM}	200	-	20k	Hz	Note4, Note5
PWM pulse width		t _{PWH}	5	-	-	μs	-

Note1: When designing of the power supply, take the measures for the prevention of surge voltage.

Note2: This value excludes peak current such as overshoot current.

Note3: The power supply lines (VDD and GND) may have ripple voltage during luminance control of LED. There is the possibility that the ripple voltage produces acoustic noise and signal wave noise in audio circuit and so on. Put a capacitor between the power supply lines (VDD and GND) to reduce the noise if necessary.

Note4: A recommended f_{PWM} value is as follows.

$$f_{\text{PWM}} = \frac{2n-1}{4} \times f_v$$

(n = integer, f_v = frame frequency of LCD module)

Note5: Depending on the frequency used, so noise may appear on the screen, please conduct a thorough evaluation.

4.3.3 Power supply voltage ripple

This product works, even if the ripple voltage levels are over the permissible values as the following table, but there might be noise on the display image.

Power supply voltage		Ripple voltage (Measure at input terminal of power supply)	Note1	Unit
VCC	3.3V	≤ 300		mVp-p
VDD	12.0V	≤ 200		mVp-p

Note1: The permissible ripple voltage includes spike noise.

4.3.4 Fuse

Parameter	Fuse		Rating	Fusing current	Remarks
	Type	Supplier			
VCC	FCC16152AB	KAMAYA ELECTRIC Co., Ltd.	1.5A 36V	3.0A	Note1
VDD	FCC16202AB	KAMAYA ELECTRIC Co., Ltd.	2.0A 36V	4.0A	

Note1: The power supply's rated current must be more than the fusing current. If it is less than the fusing current, the fuse may not blow in a short time, and then nasty smell, smoke and so on may occur.

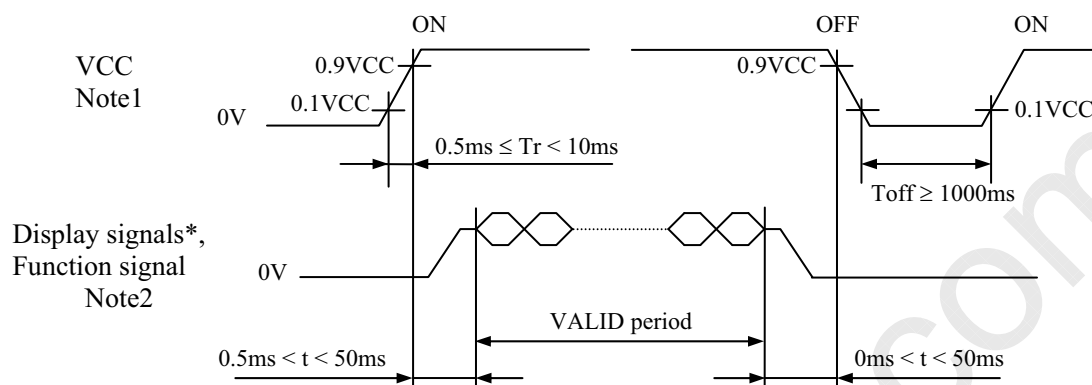
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NL10276AC30-42C

4.4 POWER SUPPLY VOLTAGE SEQUENCE

4.4.1 LCD panel



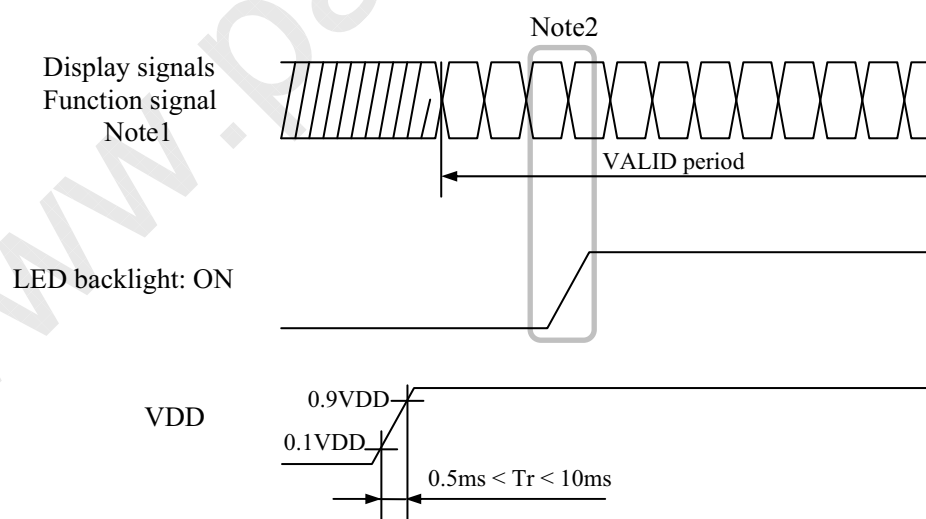
* These signals should be measured at the terminal of 100Ω resistance.

Note1: If there is a voltage variation (voltage drop) at the rising edge of VCC below 3.0V, there is a possibility that a product does not work due to a protection circuit.

Note2: Display signals (D0+/-, D1+/-, D2+/-, D3+/- and CLK+/-) and function signal (MSL) must be set to Low or High-impedance, except the VALID period (See above sequence diagram), in order to avoid the circuitry damage.

If some of display and function signals of this product are cut while this product is working, even if the signal input to it once again, it might not work normally. If a customer stops the display and function signals, VCC also must be shut down.

4.4.2 LED driver board



Note1: These are the display and function signals for LCD panel signal processing board.

Note2: The backlight should be turned on within the valid period of display and function signals, in order to avoid unstable data display.



PRELIMINARY

NLT Technologies, Ltd.

NL10276AC30-42C

4.5 CONNECTIONS AND FUNCTIONS FOR INTERFACE PINS

4.5.1 LCD panel signal processing board

CN1 socket (LCD module side): 185083-20121 (P-TWO ELECTRIC TECHNOLOGY CO., LTD.)

Adaptable plug: DF14-20S-1.25C (Hirose Electric Co., Ltd. (HRS))

Pin No.	Symbol	Signal	Input data signal: 8bit		Input data signal: 6bit	Remarks
			MAP A	MAP B		
1	VCC	Power supply	Power supply			Note2
2	VCC					
3	GND	Ground	Ground			Note2
4	GND					
5	D0-	Pixel data	R2-R7,G2	R0-R5,G0		Note1
6	D0+					
7	GND	Ground	Ground			Note2
8	D1-	Pixel data	G3-G7,B2-B3	G1-G5,B0-B1		Note1
9	D1+					
10	GND	Ground	Ground			Note2
11	D2-	Pixel data	B4-B7,DE	B2-B5,DE		Note1
12	D2+					
13	GND	Ground	Ground			Note2
14	CLK-	Pixel clock	Pixel clock			Note1
15	CLK+					
16	GND	Ground	Ground			Note2
17	D3- / GND	Pixel data / Ground	R0-R1, G0-G1, B0-B1	R6-R7, G6-G7, B6-B7	Ground	Note1
18	D3+ / GND					
19	MSL	Selection of LVDS Input data map	High	Low or Open	High	Note3, Note4
20	FRC	Selection of the number of colors	Low		High or Open	-

Note1: Twist pair wires with 100Ω (Characteristic impedance) should be used between LCD panel signal processing board and LVDS transmitter.

Note2: All GND and VCC terminals should be used without any non-connected lines.

Note3: See "4.5.4 Connection between receiver and transmitter for LVDS".

Note4: See "4.6 DISPLAY COLORS AND INPUT DATA SIGNALS".

PRELIMINARY

NLT Technologies, Ltd.

NL10276AC30-42C

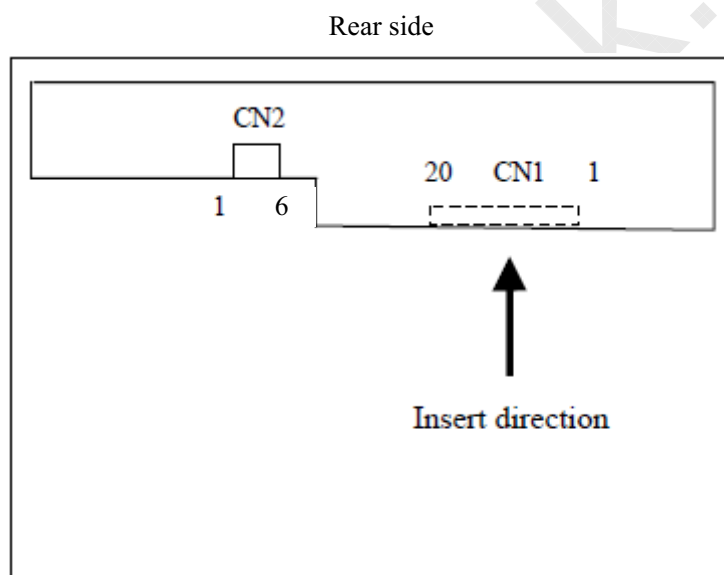
4.5.2 Backlight lamp

CN2 socket (LCD module side): MSB24038P6 (STM) or equivalent.

Adaptable plug: P24038P6 (STM) or equivalent.

Pin No.	Symbol	Signal	Remarks
1	VDD	Power supply	-
2	VDD	Power supply	-
3	GND	Ground	-
4	GND	Ground	-
5	BRTC	Back light ON/OFF control	High- On / Low- Off
6	PWM	Luminance control	PWM Dimming

4.5.3 Positions of plug and socket



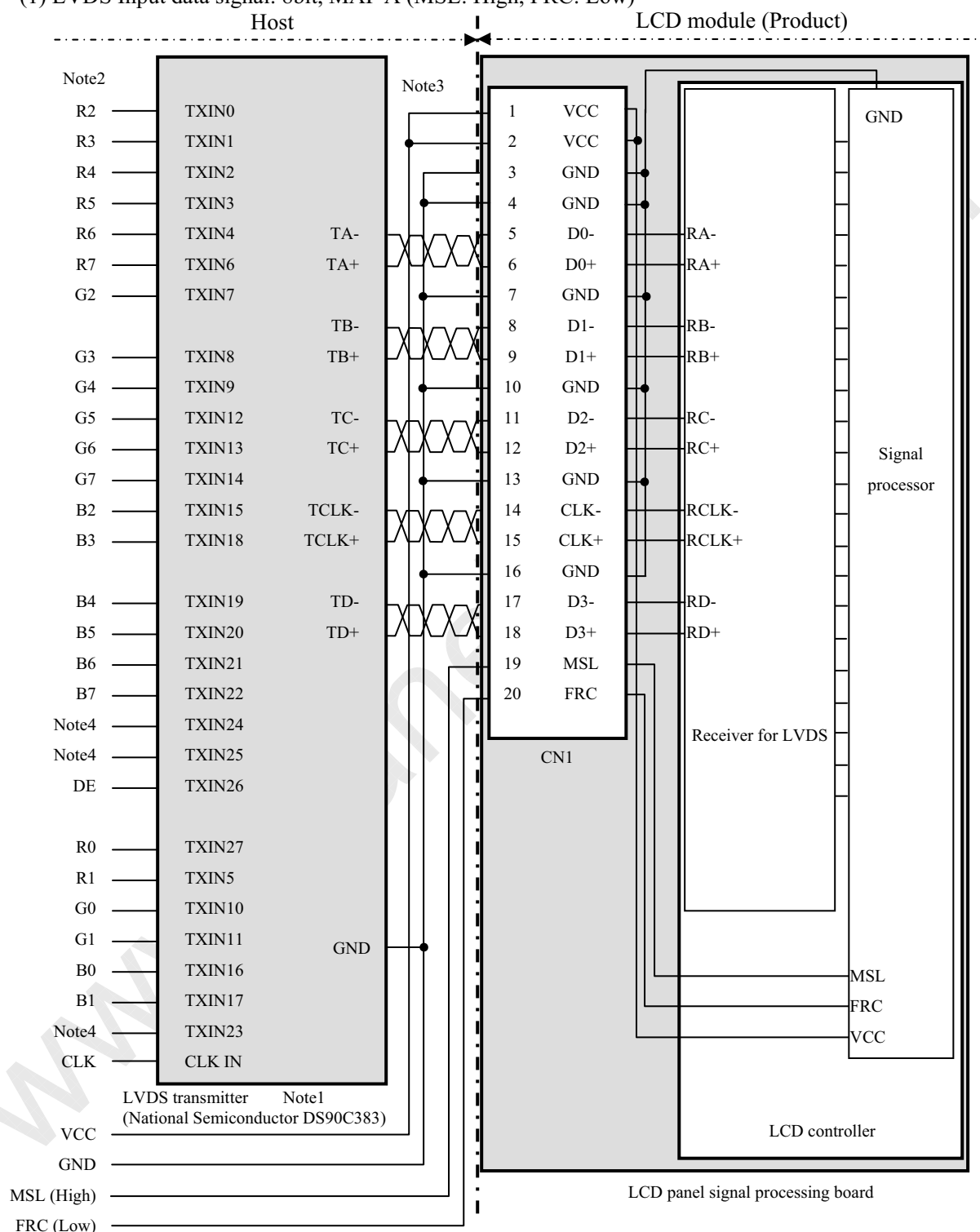
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NL10276AC30-42C

4.5.4 Connection between receiver and transmitter for LVDS

(1) LVDS Input data signal: 8bit, MAP A (MSL: High, FRC: Low)



Note1: Recommended transmitter. See the data sheet for DS90C383 (National Semiconductor).

Note2: LSB (Least Significant Bit) - R0, G0, B0 MSB (Most Significant Bit) - R7, G7, B7

Note3: Twist pair wires with 100Ω (Characteristic impedance) should be used between LCD panel signal processing board and LVDS transmitter.

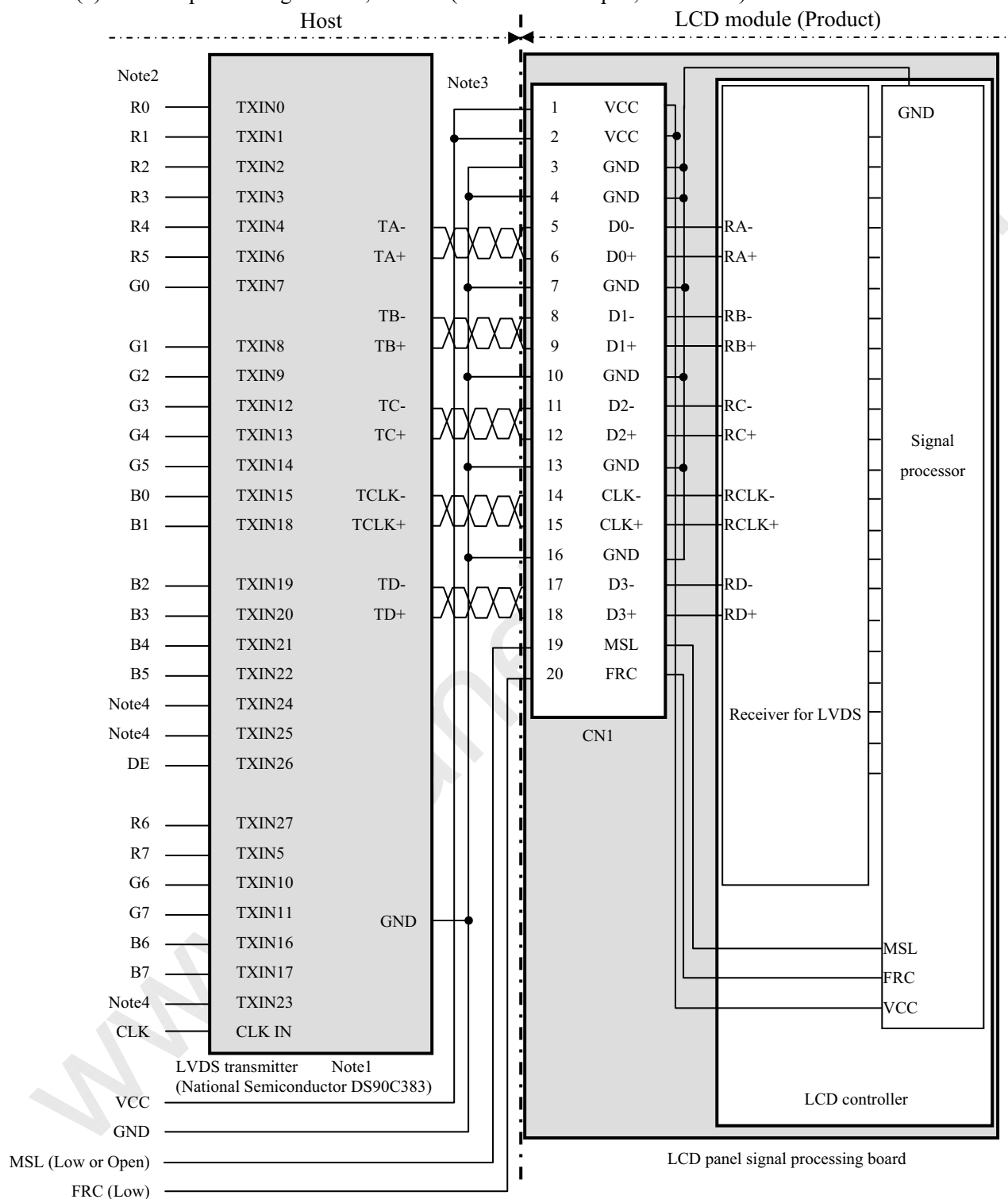
Note4: Input signals to TXIN23, TXIN24 and TXIN25 are not used inside the product, but do not keep TXIN23, TXIN24 and TXIN25 open to avoid noise problem.

PRELIMINARY

NLT Technologies, Ltd.

NL10276AC30-42C

(2) LVDS Input data signal: 8bit, MAP B (MSL: Low or Open, FRC: Low)



Note1: Recommended transmitter. See the data sheet for DS90C383 (National Semiconductor).

Note2: LSB (Least Significant Bit) - R0, G0, B0 MSB (Most Significant Bit) - R7, G7, B7

Note3: Twist pair wires with 100Ω (Characteristic impedance) should be used between LCD panel signal processing board and LVDS transmitter.

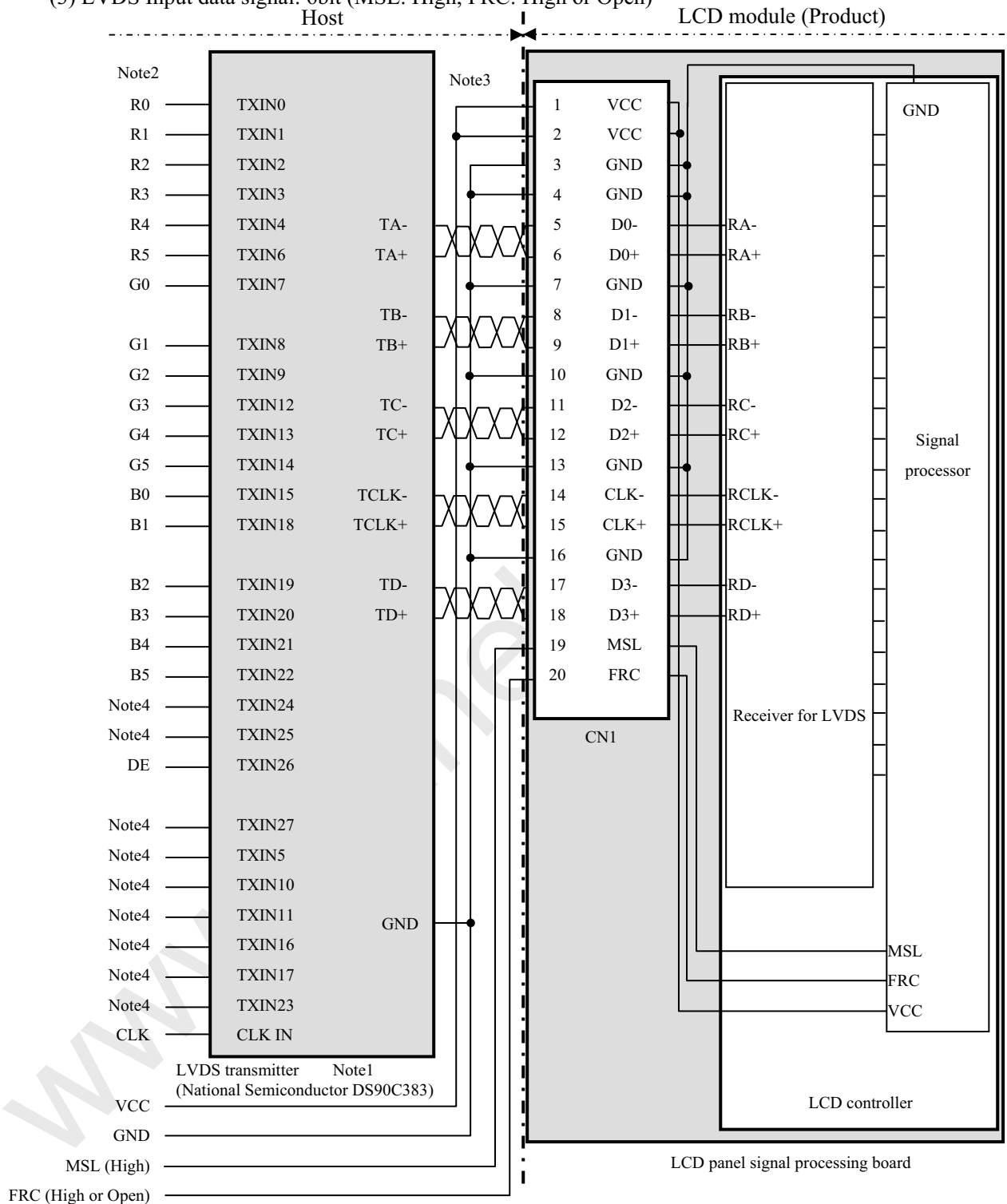
Note4: Input signals to TXIN23, TXIN24 and TXIN25 are not used inside the product, but do not keep TXIN23, TXIN24 and TXIN25 open to avoid noise problem.

PRELIMINARY

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NL10276AC30-42C

(3) LVDS Input data signal: 6bit (MSL: High, FRC: High or Open)



Note1: Recommended transmitter. See the data sheet for DS90C383 (National Semiconductor).

Note2: LSB (Least Significant Bit) - R0, G0, B0 MSB (Most Significant Bit) - R5, G5, B5

Note3: Twist pair wires with 100Ω (Characteristic impedance) should be used between LCD panel signal processing board and LVDS transmitter.

Note4: Input signals to TXIN24, TXIN25, TXIN27, TXIN5, TXIN10, TXIN11, TXIN16, TXIN17 and TXIN23 are not used inside the product, but do not keep TXIN24, TXIN25, TXIN27, TXIN5, TXIN10, TXIN11, TXIN16, TXIN17 and TXIN23 open to avoid noise problem.

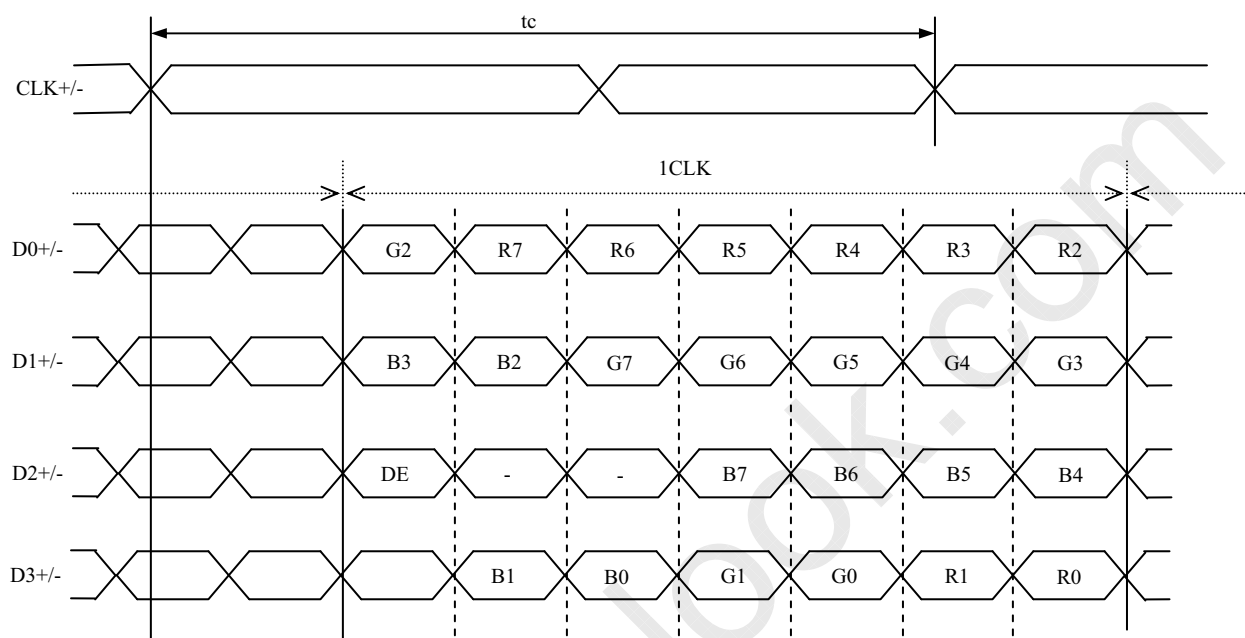
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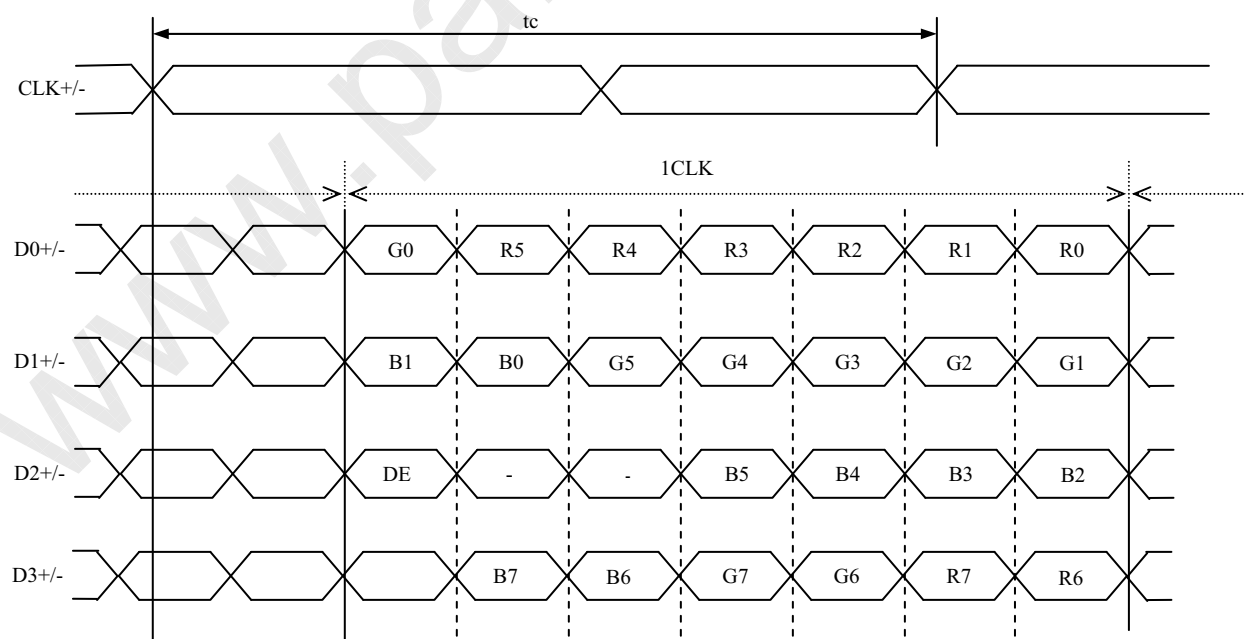
NL10276AC30-42C

4.5.5 Input data mapping

(1) LVDS Input data signal: 8bit, MAP A (MSL: High, FRC: Low)



(2) LVDS Input data signal: 8bit, MAP B (MSL: Low or Open, FRC: Low)

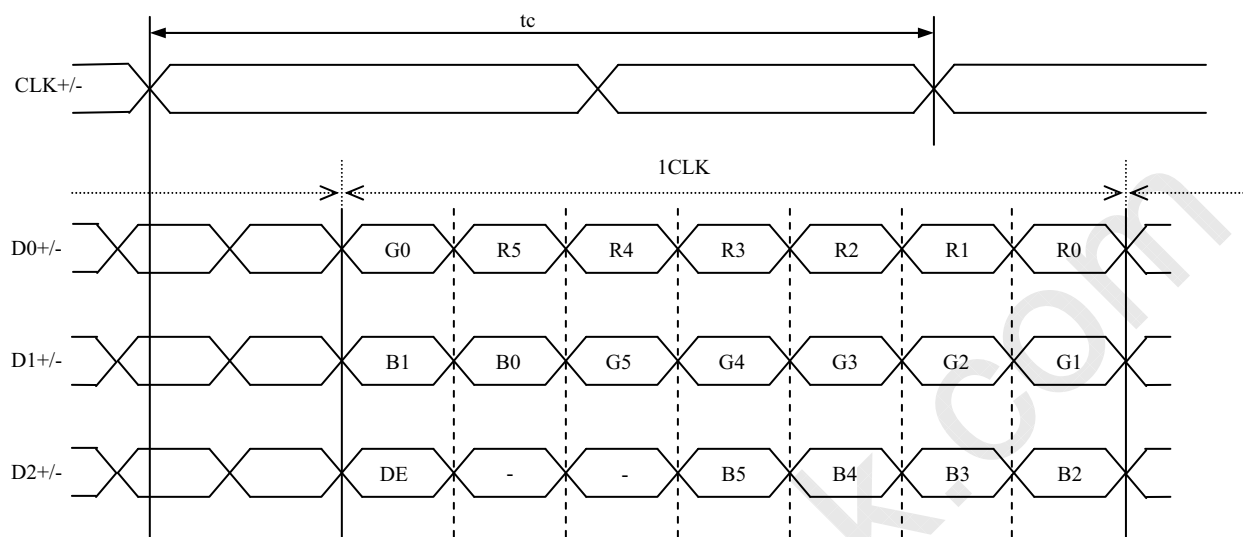


PRELIMINARY

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NL10276AC30-42C

(3) LVDS Input data signal: 6bit (MSL: High, FRC: High or Open)



4.6 DISPLAY COLORS AND INPUT DATA SIGNALS

4.6.1 Combinations of input data signals, FRC and MSL signal

This product can display 16,777,216 colors equivalent with 256 gray scales and 262,144 colors with 64 gray scales by combination of input data signals, FRC and MSL signal. See the following table.

Combination	Input data signals	Input Data mapping	CN1- Pin No.17 and 18	FRC terminal	MSL terminal	Display colors	Remarks
①	8 bit	MAP A	D3+/-	Low	High	16,777,216	Note1
②	8 bit	MAP B	D3+/-	Low	Low or Open	16,777,216	Note1
③	6 bit	-	GND	High or Open	High	262,144	Note2

Note1: See "4.6.2 16,777,216 colors".

Note2: See "4.6.3 262,144 colors".



PRELIMINARY

NLT Technologies, Ltd.

NL10276AC30-42C

4.6.2 16,777,216 colors

This product can display equivalent of 16,777,216 colors in 256 gray scales by combination ① or ②.

(See "4.6.1 Combinations of input data signals, FRC and MSL signal".)

Also the relation between display colors and input data signals is as the following table.

Display colors		Data signal (0: Low level, 1: High level)																							
		R7	R6	R5	R4	R3	R2	R1	R0	G7	G6	G5	G4	G3	G2	G1	G0	B7	B6	B5	B4	B3	B2	B1	B0
Basic Colors	Black	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Blue	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
	Red	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Magenta	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
	Green	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
	Cyan	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Yellow	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
	White	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Red gray scale	Black	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	dark ↑ ↓ bright	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		1	1	1	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Red	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Green gray scale	Black	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	dark ↑ ↓ bright	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
		0	0	0	0	0	0	0	0	1	1	1	1	1	1	0	1	0	0	0	0	0	0	0	0
		0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0
Green	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	
Blue gray scale	Black	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	dark ↑ ↓ bright	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0	1	0
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	0	0
Blue	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	

PRELIMINARY

NLT Technologies, Ltd.

NL10276AC30-42C

4.6.3 262,144 colors

This product can display 262,144 colors with 64 gray scales by combination ③.

(See "4.6.1 Combinations of input data signals, FRC and MSL signal".)

Also the relation between display colors and input data signals is as follows.

Display colors		Data signal (0: Low level, 1: High level)																	
		R5	R4	R3	R2	R1	R0	G5	G4	G3	G2	G1	G0	B5	B4	B3	B2	B1	B0
Basic colors	Black	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Blue	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1
	Red	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
	Magenta	1	1	1	1	1	1	0	0	0	0	0	0	1	1	1	1	1	1
	Green	0	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0	0
	Cyan	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1
	Yellow	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0
	White	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Red gray scale	Black	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	dark ↑ ↓	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	0					0	0	0	0	0	0	0	0	0	0	0
					:					:					:				
	bright	1	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
	Red	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Green gray scale	Black	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	dark ↑ ↓	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
		0	0	0					0	0	0	1	0	0	0	0	0	0	0
					:					:					:				
	bright	0	0	0	0	0	0	1	1	1	1	0	1	0	0	0	0	0	0
	Green	0	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0	0
Blue gray scale	Black	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	dark ↑ ↓	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
		0	0	0					0	0	0	0	0	0	0	0	0	1	0
					:					:					:				
	bright	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	1
	Blue	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1

PRELIMINARY

NLT Technologies, Ltd.

NL10276AC30-42C

4.7 DISPLAY POSITIONS

The following table is the coordinates per pixel.

C (0, 0)						
R	G	B				
C(0, 0)	C(1, 0)	...	C(X, 0)	...	C(1022, 0)	C(1023, 0)
C(0, 1)	C(1, 1)	...	C(X, 1)	...	C(1022, 1)	C(1023, 1)
⋮	⋮	⋮	⋮	⋮	⋮	⋮
C(0, Y)	C(1, Y)	...	C(X, Y)	...	C(1022, Y)	C(1023, Y)
⋮	⋮	⋮	⋮	⋮	⋮	⋮
C(0, 766)	C(1, 766)	...	C(X, 766)	...	C(1022, 766)	C(1023, 766)
C(0, 767)	C(1, 767)	...	C(X, 767)	...	C(1022, 767)	C(1023, 767)

PRELIMINARY

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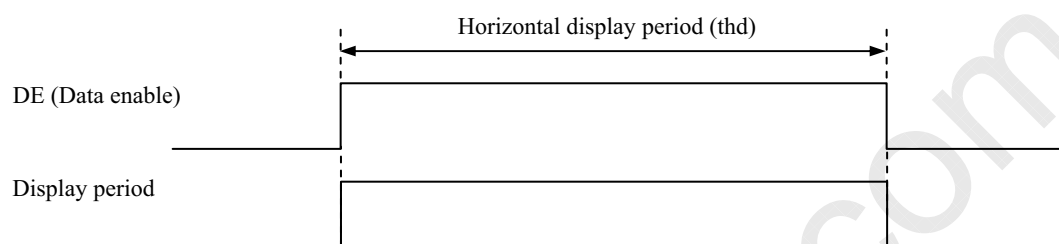
NL10276AC30-42C

4.8 INPUT SIGNAL TIMINGS

4.8.1 Outline of input signal timings

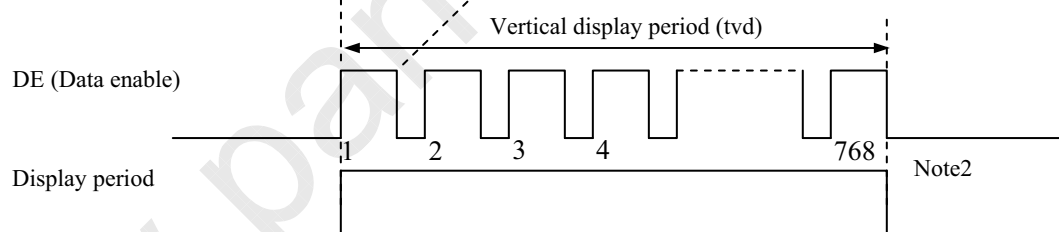
• Horizontal signal

Note1



• Vertical signal

Note1



Note1: This diagram indicates virtual signal for set up to timing.

Note2: See "4.8.3 Input signal timing chart" for the pulse number.

PRELIMINARY

NLT Technologies, Ltd.

NL10276AC30-42C

4.8.2 Timing characteristics

(Note1, Note2, Note3)

Parameter			Symbol	min.	typ.	max.	Unit	Remarks
CLK	Frequency		1/tc	50.0	65.0	81.25	MHz	15.385 ns (typ.)
	Duty		-	-			-	-
	Rise time, Fall time		-				ns	
DATA	CLK-DATA	Setup time	-	-			ns	-
		Hold time	-				ns	
	Rise time, Fall time		-				ns	
DE	Horizontal	Cycle	th	16.542	20.676	26.88	μs	48.363 kHz (typ.)
				1,100	1,344	1,800	CLK	
		Display period	thd	1024			CLK	-
	Vertical (One frame)	Cycle	tv	13.34	16.666	20.0	ms	60.0 Hz (typ.)
				780	806	1,334	H	
		Display period	tvd	768			H	
	CLK-DE	Setup time	-	-			ns	-
		Hold time	-				ns	
	Rise time, Fall time		-				ns	

Note1: Definition of parameters is as follows.

tc= 1CLK, th= 1H

Note2: See the data sheet of LVDS transmitter.

Note3: Vertical cycle (tv) should be specified in integral multiple of Horizontal cycle (th).

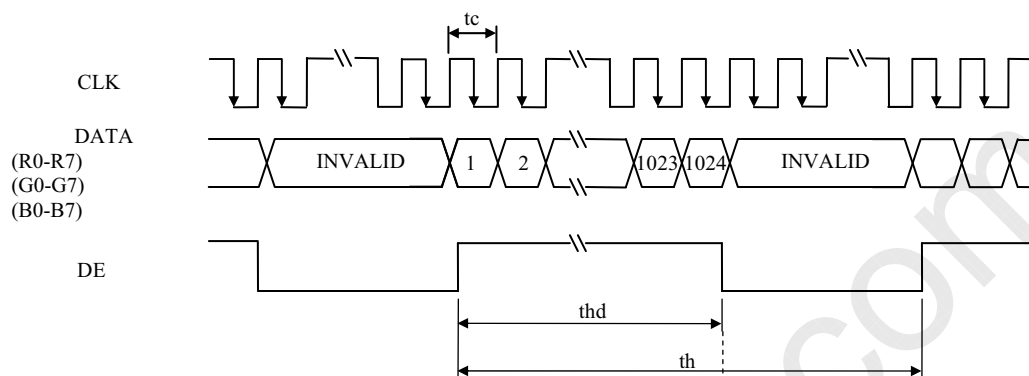
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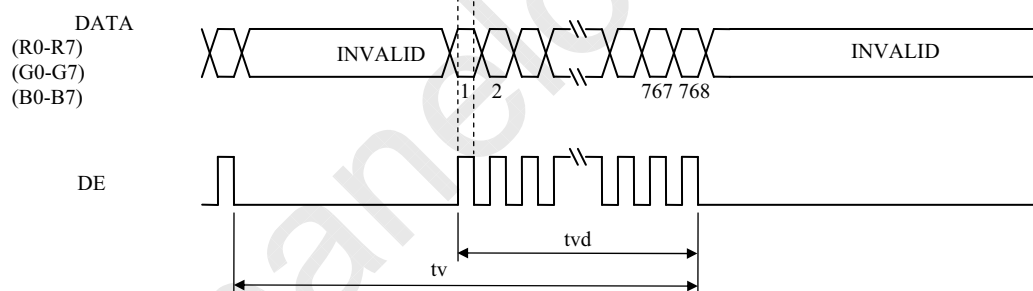
NL10276AC30-42C

4.8.3 Input signal timing chart

Horizontal timing



Vertical timing



PRELIMINARY

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NL10276AC30-42C

4.9 OPTICS

4.9.1 Optical characteristics

(Note1, Note2)

Parameter		Condition	Symbol	min.	typ.	max.	Unit	Measuring instrument	Remarks
Luminance		White at center $\theta R=0^{\circ}, \theta L=0^{\circ}, \theta U=0^{\circ}, \theta D=0^{\circ}$	L	TBD	600	-	cd/m ²	BM-5A	-
Contrast ratio		White/Black at center $\theta R=0^{\circ}, \theta L=0^{\circ}, \theta U=0^{\circ}, \theta D=0^{\circ}$	CR	400	600	-	-	BM-5A	Note3
Luminance uniformity		White $\theta R=0^{\circ}, \theta L=0^{\circ}, \theta U=0^{\circ}, \theta D=0^{\circ}$	LU	-	1.25	(1.33)	-	BM-5A	Note4
Chromaticity	White	x coordinate	Wx	TBD	0.313	TBD	-	SR-3	Note5
		y coordinate	Wy	TBD	0.329	TBD	-		
	Red	x coordinate	Rx	-	TBD	-	-		
		y coordinate	Ry	-	TBD	-	-		
	Green	x coordinate	Gx	-	TBD	-	-		
		y coordinate	Gy	-	TBD	-	-		
	Blue	x coordinate	Bx	-	TBD	-	-		
		y coordinate	By	-	TBD	-	-		
Color gamut		$\theta R=0^{\circ}, \theta L=0^{\circ}, \theta U=0^{\circ}, \theta D=0^{\circ}$ at center, against NTSC color space	C	-	60	-	%		
Response time		White to Black	Ton	-	3	TBD	ms	BM-5A	Note6
		Black to White	Toff	-	5	TBD	ms		Note7
Viewing angle	Right	$\theta U=0^{\circ}, \theta D=0^{\circ}, CR\geq 10$	θR	-	80	-	°	BM-5A or EZ Contrast	Note8
	Left	$\theta U=0^{\circ}, \theta D=0^{\circ}, CR\geq 10$	θL	-	80	-	°		
	Up	$\theta R=0^{\circ}, \theta L=0^{\circ}, CR\geq 10$	θU	-	80	-	°		
	Down	$\theta R=0^{\circ}, \theta L=0^{\circ}, CR\geq 10$	θD	-	80	-	°		

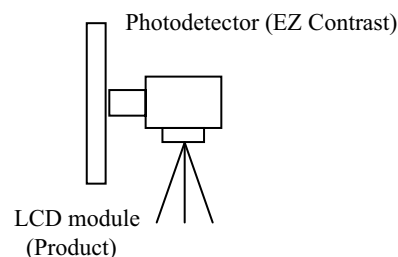
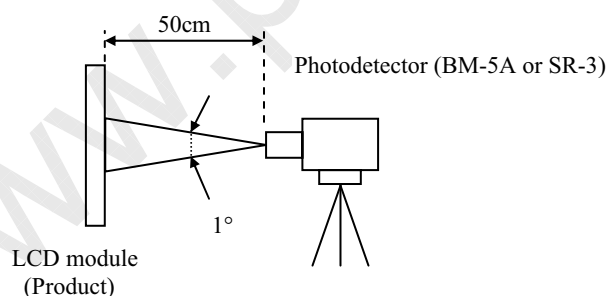
Note1: These are initial characteristics.

Note2: Measurement conditions are as follows.

Ta= 25°C, VCC= 3.3V, VDD= 12.0V, PWM: Duty 100%,

Display mode: XGA, Horizontal cycle= 1/48.363kHz, Vertical cycle= 1/60.0Hz,

Optical characteristics are measured at luminance saturation 20minutes after the product works, in the dark room. Also measurement methods are as follows.



Note3: See "4.9.2 Definition of contrast ratio".

Note4: See "4.9.3 Definition of luminance uniformity".

Note5: These coordinates are found on CIE 1931 chromaticity diagram.

Note6: Product surface temperature: TopF= TBD°C

Note7: See "4.9.4 Definition of response times".

Note8: See "4.9.5 Definition of viewing angles".

PRELIMINARY

NLT Technologies, Ltd.

NL10276AC30-42C

4.9.2 Definition of contrast ratio

The contrast ratio is calculated by using the following formula.

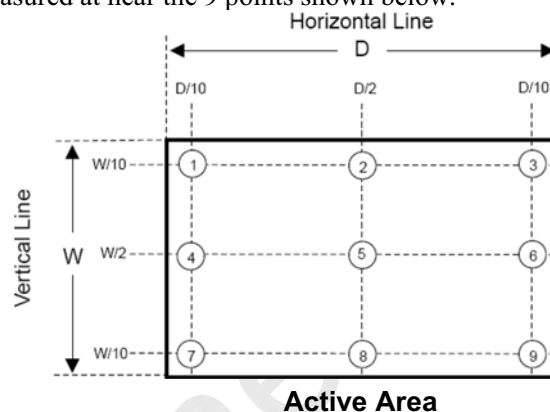
$$\text{Contrast ratio (CR)} = \frac{\text{Luminance of white screen}}{\text{Luminance of black screen}}$$

4.9.3 Definition of luminance uniformity

The luminance uniformity is calculated by using following formula.

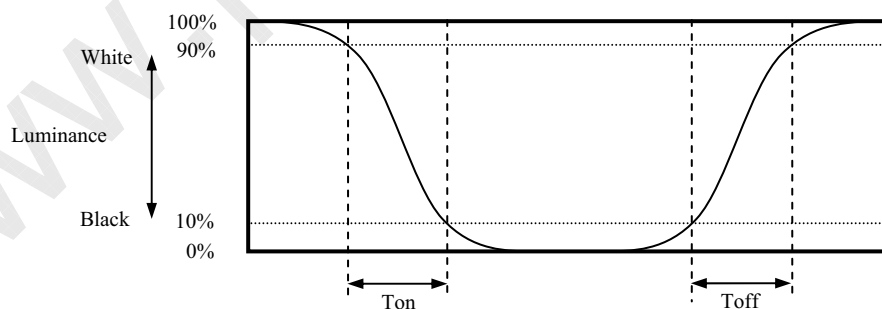
$$\text{Luminance uniformity (LU)} = \frac{\text{Maximum luminance from ① to ⑨}}{\text{Minimum luminance from ① to ⑨}}$$

The luminance is measured at near the 9 points shown below.

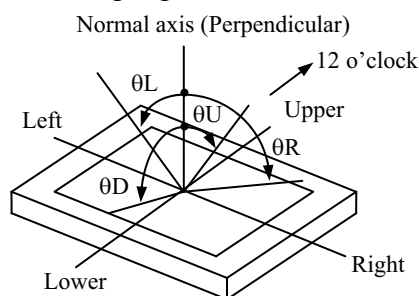


4.9.4 Definition of response times

Response time is measured at the time when the luminance changes from "white" to "black", or "black" to "white" on the same screen point, by photo-detector. Ton is the time when the luminance changes from 90% down to 10%. Also Toff is the time when the luminance changes from 10% up to 90% (See the following diagram.).



4.9.5 Definition of viewing angles





PRELIMINARY

NLT Technologies, Ltd.

NL10276AC30-42C

5. ESTIMATED LUMINANCE LIFETIME

The luminance lifetime is the time from initial luminance to half-luminance.

This lifetime is the estimated value, and is not guarantee value.

Condition		Estimated luminance lifetime (Life time expectancy) Note1, Note2, Note3	Unit
LED elementary substance	25°C (Ambient temperature of the product) Continuous operation, PWM Duty: 100%	70,000	h

Note1: Life time expectancy is mean time to half-luminance.

Note2: Estimated luminance lifetime is not the value for an LCD module but the value for LED elementary substance.

Note3: By ambient temperature, the lifetime changes particularly. Especially, in case the product works under high temperature environment, the lifetime becomes short.

PRELIMINARY

NLT Technologies, Ltd.

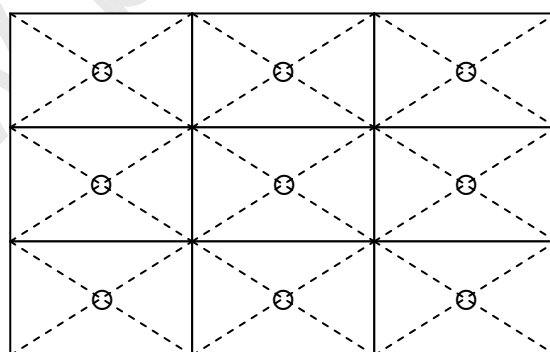
NL10276AC30-42C

6. RELIABILITY TESTS

Test item	Condition	Judgment	Note1
High temperature and humidity (Operation)	① $50 \pm 2^{\circ}\text{C}$, RH= 80%, 300hours ② Display data is black.	No display malfunctions	
High temperature (Operation)	① $70 \pm 3^{\circ}\text{C}$, 300hours ② Display data is black.		
Thermal shock (Non operation)	① $-20 \pm 3^{\circ}\text{C}$...30minutes $60 \pm 3^{\circ}\text{C}$...30minutes ② 100cycles, 1hour/cycle ③ Temperature transition time is within 5 minutes.		
ESD (Operation)	Discharge ① 150pF, 330 Ω , $\pm 8\text{kV}$ ② 9 places on a panel surface Note2 ③ 25 times each places at 1 sec interval Air Discharge ① 150pF, 330 Ω , $\pm 15\text{kV}$ ② 9 places on a panel surface Note2 ③ 25 times each places at 1 sec interval		
Vibration (Non operation)	① 5 to 100Hz, 11.76m/s ² ② 1 minute/cycle ③ X, Y, Z directions ④ 50 times each directions		
Mechanical shock (Non operation)	① 294m/s ² , 11ms ② X, Y, Z directions ③ 3 times each directions		

Note1: Display and appearance are checked under environmental conditions equivalent to the inspection conditions of defect criteria.

Note2: See the following figure for discharge points.





PRELIMINARY

NLT Technologies, Ltd.**NL10276AC30-42C**

7. PRECAUTIONS

7.1 MEANING OF CAUTION SIGNS

The following caution signs have very important meaning. **Be sure to read "7.2 CAUTIONS" and "7.3 ATTENTIONS"!**



This sign has the meaning that a customer will be injured or the product will sustain damage if the customer practices wrong operations.



This sign has the meaning that a customer will be injured if the customer practices wrong operations.

7.2 CAUTIONS



*** Do not shock and press the LCD panel and the backlight! There is a danger of breaking, because they are made of glass.**

7.3 ATTENTIONS



7.3.1 Handling of the product

- ① Take hold of both ends without touching the circuit board when the product (LCD module) is picked up from inner packing box to avoid broken down or misadjustment, because of stress to mounting parts on the circuit board.
- ② When the product is put on the table temporarily, display surface must be placed downward.
- ③ When handling the product, take the measures of electrostatic discharge with such as earth band, ionic shower and so on, because the product may be damaged by electrostatic.
- ④ The torque for product mounting screws must never exceed 0.34N·m. Higher torque might result in distortion of the bezel. And the length of product mounting screws must be $\leq$ TBDmm.
- ⑤ The product must be installed using mounting holes without undue stress such as bends or twist (See outline drawings). And do not add undue stress to any portion (such as bezel flat area). Bends or twist described above and undue stress to any portion may cause display mura.
- ⑥ Do not press or rub on the sensitive product surface. When cleaning the panel surface, wipe it with a soft dry cloth.
- ⑦ Do not push or pull the interface connectors while the product is working. When handling the product, use of an original protection sheet on the product surface (polarizer) is recommended for protection of product surface. Adhesive type protection sheet may change color or characteristics of the polarizer.
- ⑧ Usually liquid crystals don't leak through the breakage of glasses because of the surface tension of thin layer and the construction of LCD panel. But, if you contact with liquid crystal by any chance, please wash it away with soap and water.

PRELIMINARY

NLT Technologies, Ltd.

NL10276AC30-42C

7.3.2 Environment

- ① Do not operate or store in high temperature, high humidity, dewdrop atmosphere or corrosive gases. Keep the product in packing box with antistatic pouch in room temperature to avoid dusts and sunlight, when storing the product.
- ② In order to prevent dew condensation occurred by temperature difference, the product packing box must be opened after enough time being left under the environment of an unpacking room. Evaluate the storage time sufficiently because dew condensation is affected by the environmental temperature and humidity. (Recommended leaving time: 6 hours or more with the original packing state after a customer receives the package)
- ③ Do not operate in high magnetic field. If not, circuit boards may be broken.
- ④ This product is not designed as radiation hardened.

7.3.3 Characteristics

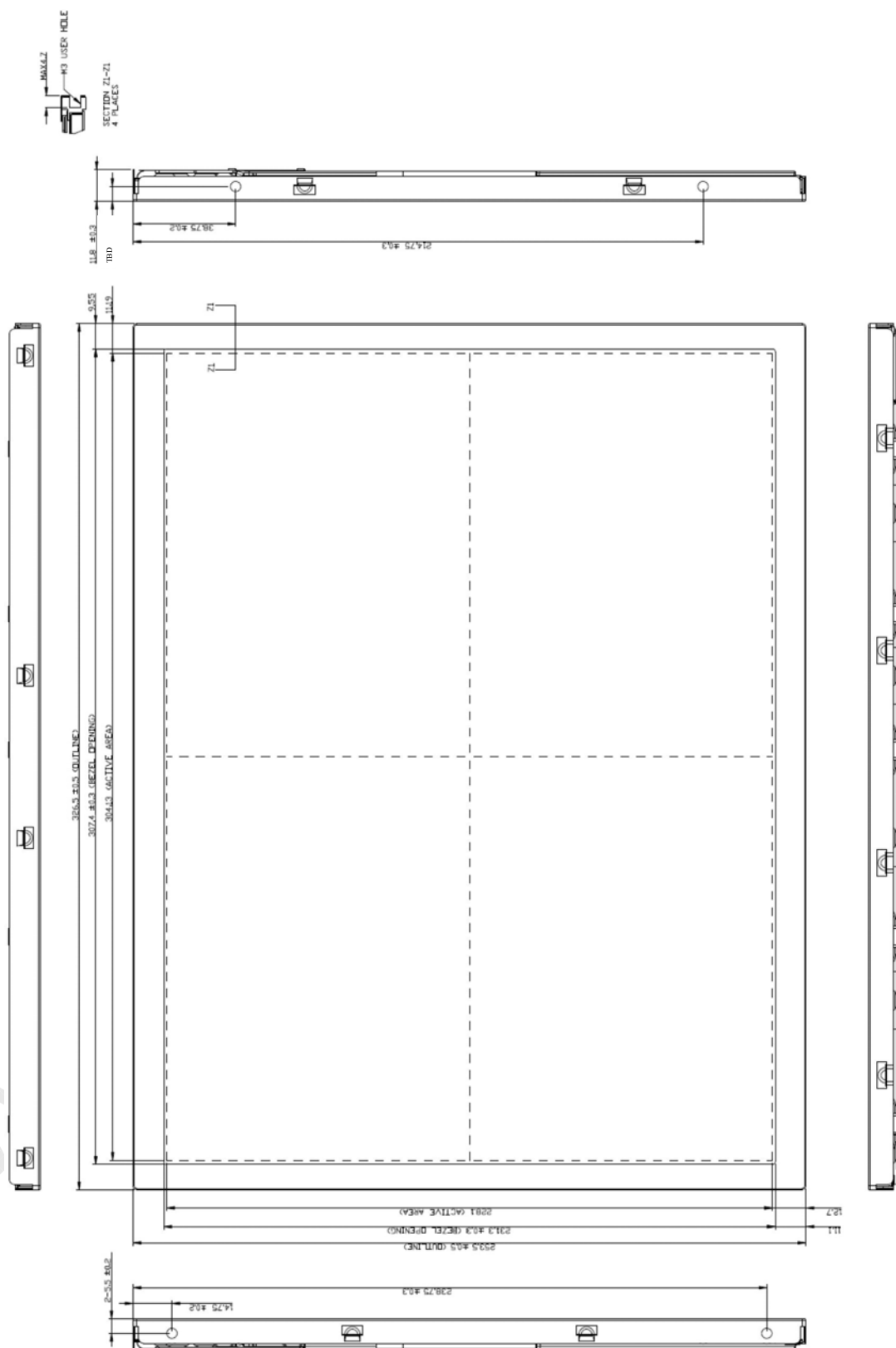
The following items are neither defects nor failures.

- ① Characteristics of the LCD (such as response time, luminance, color uniformity and so on) may be changed depending on ambient temperature. If the product is stored under condition of low temperature for a long time, it may cause display mura. In this case, the product should be operated after enough time being left under condition of operating temperature.
- ② Display mura, flickering, vertical streams or tiny spots may be observed depending on display patterns.
- ③ Do not display the fixed pattern for a long time because it may cause image sticking. Use a screen saver, if the fixed pattern is displayed on the screen.
- ④ The display color may be changed depending on viewing angle because of the use of condenser sheet in the backlight.
- ⑤ Optical characteristics may be changed depending on input signal timings.
- ⑥ The product gives AR (antireflection) coating of the polarizer surface. Though AR (antireflection) coating actualizes the low reflection with the multilayer structure, the color of reflection may differ among products and the color change of reflection may occur in the same product by fluctuation of AR (antireflection) coating.

7.3.4 Others

- ① All GND, VCC and VDD terminals should be used without any non-connected lines.
- ② Do not disassemble a product or adjust variable resistors.
- ③ See "REPLACEMENT MANUAL FOR LAMP HOLDER SET", when replacing lamp holder set.
- ④ Pack the product with the original shipping package, in order to avoid any damages during transportation, when returning the product to NLT for repairing and so on.

8.1 FRONT VIEW



Note1: The values in parentheses are for reference.

Note2: The torque for product mounting screws must never exceed 0.34N·m. And the length of product mounting screws must be $\leq$ TBD mm.

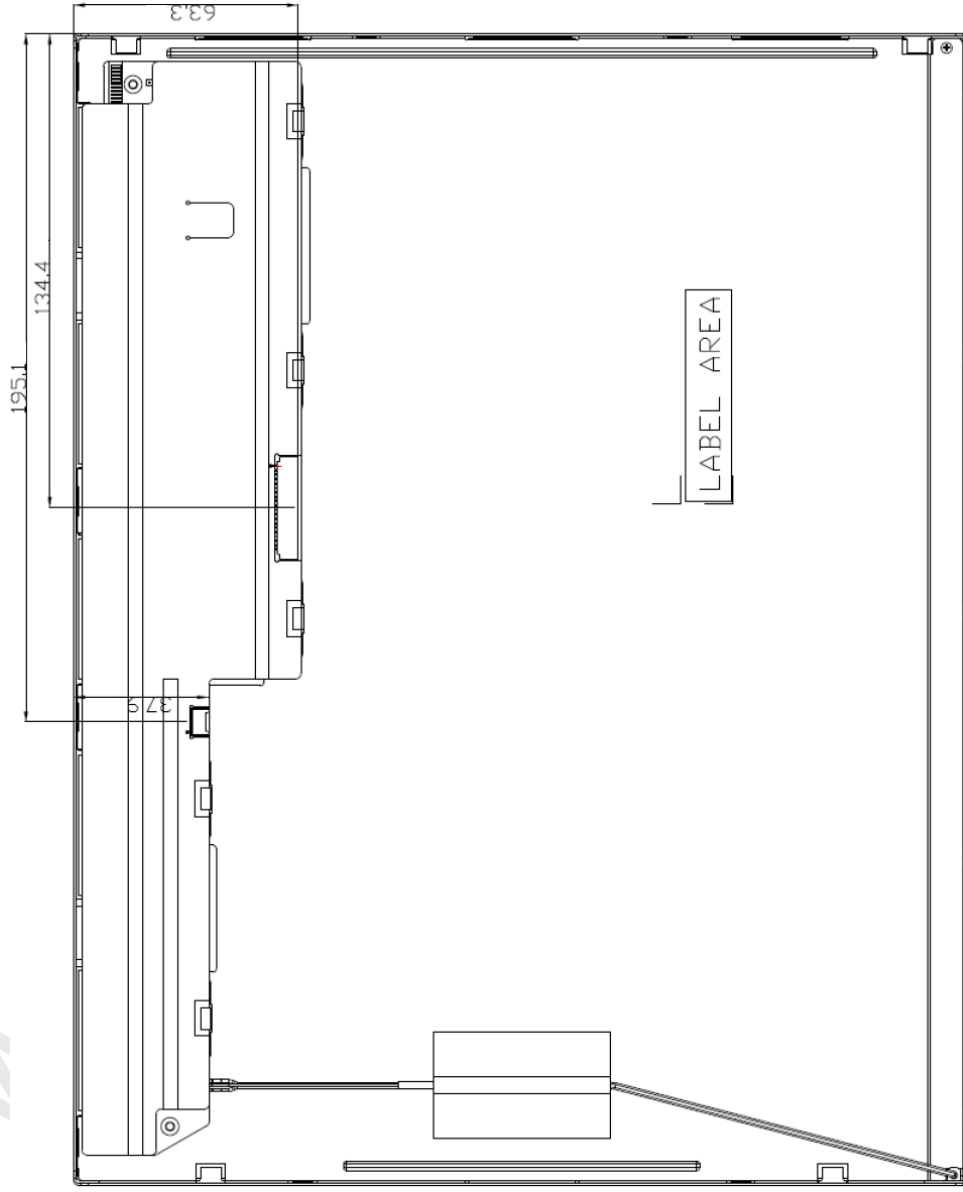
Unit: mm

PRELIMINARY

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NL10276AC30-42C

8.2 REAR VIEW



Note1: The values in parentheses are for reference.

Note2: The torque for product mounting screws must never exceed 0.34N·m. And the length of product mounting screws must be $\leq$ TBD mm.

Unit: mm



PRELIMINARY

NLT Technologies, Ltd.

NL10276AC30-42C

REVISION HISTORY

The inside of latest specifications is revised to the clerical error and the major improvement of previous edition. Only a changed part such as functions, characteristic value and so on that may affect a design of customers, are described especially below.

Edition	Document number	Prepared date	Revision contents and signature
1st edition	DOD-PP-1395	Apr. 4, 2012	Revision contents New issue Writer Approved by T. OGAWA Checked by Prepared by E. YOSHIMURA
2nd edition	DOD-PP-1413	May 10, 2012	Revision contents P8 LCD panel signal processing board • Input current for MSL signal: High: 10 (max.) μ A $\rightarrow$ (50) (max.) μ A P9 Electrical characteristics • Fuse : VCC/VDD: TBD $\rightarrow$ specified P10 Power supply voltage sequence • LED driver board: VDD (addition) P11,12 Connections and functions for interface pins • LCD panel signal processing board • CN1- Adaptable plug: P240420 (Produced by STM) $\rightarrow$ DF14-20S-1.25C (Hirose Electric Co., Ltd. (HRS)) • Backlight lamp • CN2 plug $\rightarrow$ CN2 socket (correction) Writer Approved by T. OGAWA Checked by Prepared by E. YOSHIMURA
3rd edition	DOD-PP-1436	June 4, 2012	Revision contents P12 Connections and functions for interface pins • Backlight lamp (revised) • CN2 • socket: MSB24038P5 (Produced by STM) or equivalent. $\rightarrow$ MSB24038P6 (STM) or equivalent. • Adaptable plug: P24038P5 (Produced by STM) $\rightarrow$ P24038P5 (STM) or equivalent. • Pin No.1- Signal: Power supply (12V) $\rightarrow$ Power supply • Pin No.2: GND, Ground $\rightarrow$ VDD, Power supply • Pin No.3: BRTC, Back light ON/OFF control, 5V-On / 0V-Off $\rightarrow$ GND, Ground, - • Pin No.4: PWM, Luminance control, PWM Dimming $\rightarrow$ GND, Ground, - • Pin No.5: N. C., Non connection, Keep this pin Open. $\rightarrow$ BRTC, Back light ON/OFF control, High - On / Low - Off • Pin No.6: PWM, Luminance control, PWM Dimming (addition) • Positions of plug and socket • Rear side- CN2: 1 to 5 $\rightarrow$ 1 to 6 Writer Approved by T. OGAWA Checked by Prepared by A. KUMANO



PRELIMINARY

NLT Technologies, Ltd.

NL10276AC30-42C

REVISION HISTORY

Edition	Document number	Prepared date	Revision contents and signature
4th edition	DOD-PP-1450	June 25, 2012	Revision contents P5 General specifications • Power consumption: ≤ TBD W (typ.) → ≤ 12.2 W (typ.) P7 Absolute maximum ratings • Input voltage for signals- Display signals(VD): -0.3 to +3.3 V → -0.3 to +1.98 V - Function signals(VF): -0.3 to +3.3 V → -0.3 to VCC V P8, 9 Electrical characteristics • LCD panel signal processing board • Power supply current: TBD (typ., max.) mA → 400 (typ.), (780) (max.) mA • Permissible ripple voltage: 100 (max.) mVp-p → 300 (max.) mVp-p • Input voltage for MSL signals (VFL): 0.78 (max.) V → 0.40 (max.) V • Backlight • Power supply current: TBD(typ.), ≤ TBD(max.) mA → 900(typ.), ≤ (1200)(max.) mA • Power supply voltage ripple • Ripple voltage- VCC: ≤ 100 mVp-p → ≤ 300 mVp-p - VDD: TBD mVp-p → ≤ 200 mVp-p P24 Optical characteristics • Response time- Ton + Toff (elimination) Signature of writer Approved by  T. OGAWA Checked by Prepared by  A. KUMANO